weight." Every element has a molecular symbol and a molecular weight assigned to it. Carbon, for instance, is represented by the molecular symbol C_2 and by the molecular weight 28. Now, on pp. 58 and 59 the reader is given to understand that the molecular weight of a substance is the specific gravity of the gas or vapour multiplied by 2 (the sp. gr. of hydrogen being taken as unity). On p. 130 it is further stated that carbon in all its forms is non-volatile. How then is the unfortunate student, or, in fact, any one else, to reconcile these statements with that found in the table that the molecular weight of carbon is 28, and what applies to this element applies of course to most of the others. We may also mention that in another part of the book (p. 160) a molecule of carbon is represented as consisting of twelve atoms. This may of course be a printer's error, but we find the same want of system in symbolic representation throughout the book.

We entirely agree with the authors that Inorganic Chemistry should receive more attention at the hands of chemists, but how is it that the authors do so little justice to what has been done in this branch of chemistry? Garzarolli-Thurnlackh's proof of the non-existence of chlorous anhydride is simply ignored, and the statements found in most text books with reference to this imaginary compound are again reproduced. The action of nitric acid on the metals is also represented by the usual text-book equations.

A good feature in the book is the arrangement of the properties, &c., of the substances described under different headings, which are convenient for ready reference.

There are many more points to which we might refer if space allowed, but we think we have said enough to indicate that in our opinion, at least, this new manual is not calculated to supply the "want felt, but not yet satisfied."

OUR BOOK SHELF

Technical Gas Analysis. By Clemens Winkler, Ph.D. Professor in Freiberg. Translated by George Lunge, Ph.D. (London: Van Voorst, 1885.)

PROF. LUNGE has rendered another service to the world of chemists, both students and practical men, in translating Winkler's small book on "Gas Analysis." We have here a really practical work which a man may use in a works or a teacher or student in a laboratory.

Winkler's book is scarcely known in this country, and we may venture to say that several, if not most, of the gas apparatus figured and described in this book are also scarcely known.

The book is decidedly practical, and treats in the first instance of methods of collecting gases; on measurement of gases; and on apparatus and methods of analysis. The translator has added a chapter on the nitrometer, and shows how it may be used for more extended analyses than the examination of nitrous vitriol. An appendix of useful tables makes the book a very valuable laboratory companion.

Lessons in Elementary Chemistry, Inorganic and Organic. By Sir Henry E. Roscoe, LL.D., F.R.S., Professor of Chemistry in the Victoria University, Owens College, Manchester. New Edition. (London: Macmillan and Co., 1886.)

THIS favourite text-book is so well known to students of chemistry that, whilst calling attention to the appearance of a new edition, we need only remark that the author has introduced several changes and additions which bring the book as well up to date as the limits of a work of this size will permit.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

New System of Earthquake Observations in Japan

OWING to the invention of new seismographs by the members of the Seismological Society of Japan, there has been of late a complete change in the system of earthquake observations in this country. The Meteorological Bureau now employs the horizontal pendulum and vertical-motion seismographs of Profs. J. Milne and T. Gray, and of Prof. J. A. Ewing for systematic observation, while the Imperial University of Tokio publishes from time to time detailed accounts of particular and more interesting shocks by the use of similar instruments. These seismographs register on a revolving glass plate or drum automatically started by the earthquake motion, components of horizontal and vertical motions of the earth on a magnified scale, thus producing continuous diagrams, and indicating successive displacement of the ground in conjunction with the time.

The account of the earthquake of December 28, 1885, the largest shock during the last three months, is here given as a sample of seismic record now issued in this country. The meanings of the terms employed are as follows: a, semi-amplitude of seismic wave; T, period of complete wave; V, maximum velocity in mm. per sec., or $\frac{2\pi a}{T}$; α, maximum acceleration in mm. per sec. per sec. or $\frac{V^2}{a}$.

At the Imperial University of Tokio, Japan, at 10h. 6m. 30s. on December 28, 1885

Maximum semi-amplitude of horizontal motion a_1 ...	1·8
Complete period T_1 corresponding to the max. horizontal motion	1·5
Maximum semi-amplitude of vertical motion a_2 ...	0·3
Complete period T_2 corresponding to the max. vertical motion	0·6
Direction of the max. horizontal motion	E.–W.
Duration	3m. 30s.

Remarks.—The motion slowly commenced, not accompanied by quick tremors, as is usually the case. At the 14th second from the commencement a considerable E.-W. motion occurred; in another second the maximum movement appeared in the same direction, which was followed by smaller shocks during about one minute; and from thence the oscillations gradually subsided. As usual, the particles of the ground did not move to and fro, but traced a curvilinear path, although the E.–W. components always remained greater than the S.–N. components. In all, over 130 shocks or complete waves were registered.

From figures given in the above table, the maximum velocity V and the maximum acceleration α may be calculated, which are, in this case for the horizontal motion, 7·6 mm. per sec. and 39 mm. per sec. per sec. respectively. The latter quantity is the measure of the *intensity* of the earthquake, and may be employed in determining the overthrowing power of body and shattering and other destructive effects produced on buildings. Although the records given by the oscillations of fluids, fissures on walls, rattling of wine-glasses, &c., might tell something about the nature of earthquakes, and are indeed invaluable in absence of suitable instruments, yet for the *absolute* measurements of seismic force the method above cited, I believe, is by far the best that has ever been attempted on this subject.

I may add in respect to the above earthquake, and in general, that the vertical motions are always—in our experience—smaller than horizontal ones, and the maxima and minima of these two kinds of motions are not synchronous. I shall have

occasion before long to communicate to you the general results of all observations made during past years.

An equally interesting set of observations carried out by the Meteorological Bureau was the determination of areas shaken in every earthquake, together with the reductions of results during the years 1885-86—the works of which I was directed to superintend. The method followed out was almost exactly the same as that originated by Prof. J. Milne in studying "387 earthquakes in North Japan," an epitome of which appeared some time ago in your columns. This method is briefly as follows. Observation-books furnished with directions for reporting earthquake phenomena with or without instruments were distributed, authorised by Government, among over 600 local offices throughout the empire; in fact, the earthquake observations were made a part of the duty of local officers, and the reports were transmitted free of postage. From the reports sent in by different observers thus closely stationed, maps have been made showing the disturbed area in every shock, and a summary of observations has been compiled.

The results worked out from a large number of these maps and their notes have revealed many interesting facts, and entirely confirmed the previous works of the eminent seismologist above mentioned.

The total number of earthquakes in Japan in 1885 was 482, equivalent to 1·3 shakings a day. In Tokio alone 68 shocks were registered. Earthquakes are most prevalent in Yezo, and the north and central portions of the main island along the eastern or the Pacific coast, but in provinces bordering the Japan Sea they are few, and in some places none at all; if they occur, they are generally limited to small tracts of land. Speaking of the main island in general, the range of mountains traversing through and forming the backbone of Central Nippon appears to divide it into two zones of different seismatic activities. In Kiushū, Shikoku, and other islands, disturbances are comparatively small.

Most larger earthquakes originate beneath the ocean. The majority of shocks are only local. Of the whole number, 235 local disturbances were recorded, which have not extended more than 100 square miles of land area. The maximum area of *one* earthquake was 34,700 square miles. The aggregate area of disturbance during the year was 796,000 square miles, and taking the total area of the empire to be 147,000 square miles, it is equivalent to saying that the whole of Japan has been shaken 5·4 times in one year. In summer shocks are less prevalent than in winter. The earthquakes occur in groups, that is to say, when disturbances occur, they are limited within certain portions of country, not generally extending beyond these limits. Propagations of seismic waves are often stopped by mountain-chains.

Finally, I may state that we shall continue these observations in future, and I hope the results to be obtained from more years' work of this nature will be some help in throwing light on the physics of the earth's crust. SEIKEI SEKIYA

The Imperial University of Tokio, Japan, February 28

"The Krakatão Dust-Glows of 1883-84"

IN your issue of March 25 (p. 483) the writer of the critical notice of Dr. Riggenbach's pamphlet on the above propounds a statement which, if true, is of vast importance in accounting for the subsequent optical phenomena which are supposed to have been connected with the eruption. He says: "Thus the hurling into the air of 150 cubic kilometres of volcanic dust in August 1883," &c. Whence does he deduce this enormous quantity? M. Verbeek, in his "Krakatão," part 1, which I have carefully perused, estimates the entire volume of ejecta (chiefly based on what fell near the spot) at only 18 cubic kilometres, and as his work is the only reliable source of information regarding the eruption with which I am acquainted, I am entirely at a loss to conceive how the 18 has been suddenly magnified into 150.

As one of the Krakatão Committee of the Royal Society, I have naturally examined the theoretical possibility of the amount of dust ejected having been sufficient to account for the optical phenomena witnessed, and have been obliged to content myself with the very modest quantity of 4 cubic kilometres out of the total 18, but if your writer's statement is correct, I am evidently at liberty to considerably augment the quantity at my disposal, and it is needless to say that this would seriously change the aspect of the question. E. DOUGLAS ARCHIBALD

April 15

Pumice on the Cornish Coast

Is Mr. Guppy sure that the "pumice" he records in NATURE for April 15 (p. 559), as found on Maenporth Beach, is the natural article? I ask because of having been accustomed to find pieces of a pumice-like stone, many light enough to float on the sea, along the Suffolk coast. This, however, is an artificial product, a sort of cinder from steamers, though it has deluded many people. It puzzled me for some time.

W. WHITAKER

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Ferocity of Animals

IF your correspondent in last week's NATURE (p. 583) will treat a wild rat in the way which I described, the animal will answer his question much more effectually than I can. For while I have only words at my disposal whereby to convey any "ejective" information upon the subject, the rat will display the fact of his understanding your correspondent's intention by a thousand co-ordinated movements of a much more eloquent kind.

The paper by Mr. Lloyd Morgan in the current issue of *Mind* is merely a republication of his views as already presented in this periodical. Having replied to these views as fully as seemed to me desirable when they were first expressed, it is needless that I should now go over the same ground a second time. It will, therefore, be sufficient to refer your correspondent to the discussion between Mr. Morgan and myself, which he will find in consecutive issues of NATURE for February and March 1884.

GEORGE J. ROMANES

The Climbing Powers of the Hedgehog

I REMEMBER many years ago we kept a hedgehog on the Continent in an upper garden well walled in. There she remained for some time, until she littered four or five young in a rubbish heap in a corner. The young having grown, and being able to move about, she and her whole brood disappeared. Her only way was over a wall four or five feet high, on which she left traces, but the young could not have been able to climb this, and she must have carried them. HYDE CLARKE

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ON THE LAW OF THE RESISTANCE OF THE AIR TO THE MOTION OF PROJECTILES

IN my experiments made to determine the resistance of the air to the motion of projectiles, it was assumed that this resistance followed *some law* producing a gradual change in the velocity, and consequently that the times occupied by the shot in passing over a succession of equal spaces would admit of being differenced. This method of proceeding gave the required result in the form of a coefficient K_v of v^3, in terms of the second and higher differences of time above referred to, when the time was expressed in seconds to five places of decimals. So long as this value of K remains constant, the resistance of the air varies as the *cube* of the velocity The first results obtained were published in a note in the *Phil. Trans.* for 1868, p. 441. The experiments were afterwards more carefully calculated, and given in detail in the Reports published by Government in 1870. In using these results to calculate general tables for space and time, for cases where the projectile could be supposed to move approximately in a straight line, and free from the action of gravity, the corrected mean values of K_v were used, and made to vary with the corresponding velocity v. And in my "Treatise on the Motion of Projectiles" (1873), the *cubic* law of resistance was used for the purposes of calculation, so that for those velocities where K varied it was necessary to divide the trajectory into such small arcs that, throughout each arc, the average value of K could be used without sensible error. This treatment of the question rendered it unnecessary for me to attempt to express the law of resistance according to powers of v for all practical velocities. But from the results of my experiments for velocities between 900 and 1700 f.s., I remarked